1946 452

# PONDEROSA PINE GROWTH STUDIES

BY

HAROLD WEAVER

FOREST SUPERVISOR, COLVILLE INDIAN AGENCY

For the past seven years the foresters of the Regional office and the Superintendent and forestry staff of the Colville Reservation have been attempting to assemble data necessary for the formulation of the Indian Service portion of a management plan for the Omak-Okanogan Cooperative Sustained Yield Unit. The work has been pursued sporadically, because of the shortage of man power and the press of routine duties in connection with other forestry work, and during the War progress ceased almost entirely. Nevertheless a considerable amount of basic data has been collected and it appears that in the not too distant future a solution of the various problems involved may be arrived at. A discussion of these problems, particularly those in connection with ponderosa pine growth studies, may be of interest to the officials of other agencies.

Before sustained yield management plans can be prepared for any forest property it is first necessary that there be assembled certain basic information concerning the forest itself. Such should include (1) reasonably accurate forest type maps, (2) a forest inventory, showing total volumes by species and average volumes per acre for different types and site classes and (3) estimates of growth attainable under applicable silvicultural systems. Most of the Indian reservations of the Pacific Northwest, to the

writer's knowledge, have reasonably accurate maps and forest inventories. Estimates of growth, however, unless considerable detailed information concerning the stands is first collected, can be based on nothing better than pure guesswork.

## WHY GROWTH STUDIES ARE NECESSARY

It may first be asked, "Why are growth studies necessary?" Growth studies are necessary for the determination of the probable or potential yield in forest products that can be obtained from the land. In comparison the farmer will want to know the quantity of corn or oats per acre that can be obtained from a given piece of land. If he is smart he will also want to know the proper plan of management that will insure maximum production indefinitely and that, at the same time, will not deplete the basic resource, namely the land. Similarly the stockman will want to know the potential maximum production that can be obtained from his range land, as expressed in pounds of beef or mutton, or pounds of wool. He will also want to know the plan of management under which such production can be obtained without damaging or depleting the basic resource.

To insure a sustained yield of forest products the forester must know what his land will produce and under what silvicultural cutting or harvesting systems such production may be obtained. Knowing the yield per acre and the number of acres involved the forester can with reasonable accuracy compute the allowable yearly cut or harvest. He will also have information on which he can base proper harvesting methods for the present virgin timber stand. In the latter connection one prominent forester has stated that 2/ "From a forestry standpoint our most important problems in the western forests are (1)

prolonging the life of the virgin timber, and (2) conducting the first cutting in such manner as to make the greatest headway in the process of converting the helter-shelter virgin forest to a manageable one with the utmost economy."

Continuing the comparisons, the computation of forest yield is a tremendously more complicated process than is the computation of the yield of oats, corn or grass. Such plants are comparatively short lived and results obtainable under different systems of management can be observed and analyzed in but a few years. Errors and abuses in management are also readily observed and corrections can be initiated. Forest trees, in contrast, require from 40 or 50 to 120 or even 150 years to grow to merchantable size. Since forestry in this country is comparatively young it can be readily understood why we are "sailing seas that are largely uncharted". We may never live to see the results of our good work and our mistakes, of which there doubtless are many, may someday be analyzed and commented on by succeeding generations of foresters. In the latter connection it is the writer's opinion that the ecology of ponderosa pine is still imperfectly understood, 4/ that further study is needed and that it may be necessary to revise some of our silvicultural and protection policies in the light of such.

## HOW GROWTH STUDIES ARE CONDUCTED

The easiest method of collecting data from which reasonably accurate growth estimates can be made is to actually measure the growth that has occurred on cut-over lands. Knowing the diameter and height of any reserve tree at the time that the selective logging occurred and the dimensions of the tree at stated subsequent intervals, it is simple procedure to compute therefrom the merchantable board foot volumes. By subtracting the volume of the tree at the time of selective logging, say in 1916 for instance, from the volume of the tree in

1946 we obtain the growth or "increment", expressed in board feet. This figure, divided by 30, the total period of elapsed years, will give us the average growth per year. By measuring all of the trees over extensive areas in such manner we can divide the total average growth per year by the acreage involved to obtain the growth per acre per year.

Similar measurements taken of trees in virgin stands, it should be mentioned, will not give accurate results, for the reason that such trees do not exhibit the sometimes tremendous growth acceleration that results when the competing mature and over-mature trees are removed by selective logging.

With sufficient samples on hand of varying quality it should be possible to predict the growth that will occur on other similar lands under similar systems of cutting. Unfortunately, on most of the Indian lands, cutting operations have been of too short duration to afford any samples of growth over an extended period of time. On the Colville Reservation, for instance, selective logging operations have only been in progress since the year 1919. Even so it would be feasible to measure growth that had occurred and to make predictions therefrom had it not been for the fact that a "diameter limit" system of selective cutting was first used, probably because of considerable uncertainty concerning the ownership status of the land, and practically every merchantable tree was cut. Now, over extensive areas, there remains no reserve stand to which the loggers can return during the second cutting cycle. Poles and seedlings are present in abundance, to be sure, but not until the third or fourth cutting cycle, long after our time, will such trees be of adequate saw-log size. These trees have no merchantable board foot volume to measure at the present time. Not until the early 1930's was there initiated a policy of leaving an adequate

reserve stand on the Colville.

On the Yakima and Warm Springs Reservations selective logging operations have been of exceedingly short duration. On the Klamath Reservation, however, selective logging operations have been in progress since 1916 and from the very first an adequate reserve stand has been left. Measurement of growth in samples of these stands would certainly be a worth while project.

Even in adequate reserve stands on such older cut-over lands a certain amount of error is certain to occur because of the lack of annual or periodic records extending back to the time of cutting. When looking at a tree that has died of beetle attack, for instance, we sometimes can not be reasonably certain that the tree died during the period of years being studied, or before that time. Proper allowance for mortality and loss in merchantable board feet volume, resulting from the death of such trees, is quite an important item when growth predictions are applied to other portions of the stand. Similarly, though we can determine the diameter of the tree at the time of cutting by taking increment core borings, it is usually impossible to determine its height. The best that can be done is to estimate the height from graphs or curves showing average height over diameter.

Lacking reserve stands of sufficient age since the time of selective logging to afford average growth figures over a considerable period of years, the only alternative is to apply growth prediction techniques evolved by the forest experiment stations of the Forest Service, Department of Agriculture. The Pacific Northwest Forest Experiment Station, for instance, has evolved what appears to be a very accurate growth prediction system from measurements extending over a long period of years from a large number of sample plots. 1/ Accurate applica-

tion of the system depends on a detailed preliminary analysis of the stand. In order to gain some understanding of such it is first necessary that there be briefly discussed the nature of the ponderosa pine forest itself.

## THE PONDEROSA PINE FOREST

In the typical ponderosa pine forest many different age classes are represented, in contrast to the much denser Douglas fir, western hemlock and Sitka spruce forests of the Coast, and the stand is described by foresters as being "all aged". Some even go so far as to aver that 250 or 300 different age classes may be found on any particular area, even areas of small size. While it may be possible to find trees of all ages from one year to 300 years, if one should search with sufficient intensity over a large area, it is obvious that the virgin forest is really comprised of even-aged groups of trees in various stages of maturity. There is abundant evidence that this condition has been caused by periodic or occasional attacks of tree killing insects and by periodic light surface fires. 4/

Nearly every year tree killing insects, particularly the western pine beetle, can be observed killing single trees and groups of trees in the virgin forest, usually selecting the weakened individuals and the older groups. About such deadened trees thickets or groups of seedlings usually develop. Inevitably, before the coming of the foresters and initiation of the present protection policies, running surface fires started by lightning or by Indians attacked these dead trees and thinned the reproduction groups by killing most of the little trees. Usually enough of the little trees survived to eventually comprise the even-aged tree groups that we now observe in the forest. The ashes of the burned out snags and windfalls also afforded excellent

ponderosa pine seedbeds. The tree ring and fire-scar record indicates clearly that for countless centuries such periodic fires occurred at fairly frequent intervals, whenever dead needles, twigs, dry grass and other debris accumulated in quantities sufficient to support combustion, when weather conditions were favorable and when some natural or human agent caused them to be started.

By the present marking system on timber sales the Indian Service is attempting to harvest the over-mature trees and all trees of poor health and vigor in other age classes. In other words we are attempting to substitute harvesting of such trees by the saw for nature's harvesting by pine beetles and fire, leaving the groups of younger trees of good vigor to continue growing.

The development of a growth prediction technique for a reserve stand in which so many different age classes are represented is a complicated undertaking. It should be remembered that precipitation is scanty in the ponderosa pine region and that competition between the trees for the limited soil moisture is keen. Drought periods or comparatively wet periods are therefore reflected by poor or excellent tree growth. The number of trees competing with each other is also of influence on growth, for the greater the number of trees left the less will be the growth per tree. If too many are present the trees simply refuse to grow and a condition of "growth stagnation" results. The type of tree left also has influence on rate of growth. A tree with a well developed, healthy crown and root system has a decided edge over other trees less fortunately endowed.

## FACTORS THAT AFFECT GROWTH OF THE RESERVE STAND

The following are the factors that the forest researchers must consider when developing a growth prediction technique: 1/

1. Tree classes, referred to above. Growth rates of living organisms always vary with their age and vigor. These two fundamental variables form the basis of the Keen tree classification, under which individual trees are grouped into four age classes, namely young, immature, mature and overmature, and into four crown vigor classes designated as full vigor, good to fair, fair to poor, and very poor. Thus the individual tree can be classified under one of 16 groups, depending on its age and vigor.

2. Diameter within tree classes. The larger trees, generally, are the older trees, and they grow less rapidly than do the smaller, younger individuals of the same class.

3. Site quality. The rate at which any class of tree grows depends largely upon the soil and climate conditions of the area upon which it is situated. The relative productive capacity of a given forest area is referred to as its site quality. Such quality can best be measured by the height of the dominant trees on any given area.

4. Stand competition, referred to above. Growth of the individual tree depends not only on its own age, vigor, size and productive capacity of its site, but also on the number, size, proximity and competitive ability of its neighbors.

5. Species composition. Growth rates of other tree species sometimes associated with ponderosa pine, such as Douglas fir, white fir, western larch and lodgepole pine, are not known in comparable detail. It therefore is apparent that much work remains to be done.

6. Change in tree class. After the overmature trees of a stand are removed a reserve tree of fair to poor vigor, for instance, may be released in such manner that it may eventually become a tree of full vigor. Such changes have not yet been fully accounted for in growth prediction technique.

7. Length of growth period. Such has apparently not been found to have any particular influence, in the Pacific Northwest, up to at least 40 years.

8. Climatic cycles, previously mentioned. A growth prediction technique based on measurements taken during a period of drought would, of course, give results that would be too conservative. The measurements should, therefore, cover periods of both good and poor growth to obtain average or "normal" growth rates.

9. Growth of the pole stand. Under present utilization standards a tree is not considered to have reached merchantable size until it has reached a diameter of 12 inches and can furnish at least one log that can be sawed into boards. During the next 40 year period quite a number of trees considered poles at the present time will grow into the merchantable tree class. These trees are referred to as "recruits". Growth prediction technique must therefore take into

consideration those trees that will later become merchantable.

10. Tree mortality. Even in the reserve stand, comprised of trees of the younger, more vigorous classes, loss is constantly occurring from insect attacks, wind break, snow break, lightning, etc. Measurement of loss resulting from such is therefore necessary if new forest growth is to be predicted accurately.

The forest research men have measured most of the variables resulting from these inter-related factors and have analyzed the results by statistical methods. They also have compiled tabulations and alignment charts by which such variables can be accounted for when predicting growth for any ponderosa pine stand. It can therefore be readily understood why, as has been indicated, accurate application of the growth prediction technique depends on a detailed preliminary analysis of the forest.

METHODS USED ON THE COLVILLE RESERVATION

On the Colville Reservation, on the Kettle Timber Unit, the sample plot method was used for collecting the necessary basic data. The samples consisted of 1/4 acre circular plots taken five chains apart on transect lines that were oriented by Land Office subdivisions and tied in to section corners. In all 762 samples, comprising 190.5 acres were taken on strips having a total length of 49 miles.

On each quarter acre circular plot all live trees above three inches in diameter were measured and tallied by even inch diameter classes. In addition all of the ponderosa pines were tallied by Keen's tree classes. Douglas fir and western larches, since we know nothing better to do, were tallied merely by diameter classes, as indicated. Total height measurements were taken, in connection with each plot, to determine site class.

From this data, for the various site classes, there were then compiled

stand tables, showing board foot volumes, and stock tables, showing number of trees, for each even inch diameter class and for each of the 16 Keen tree classes. These figures were then reduced to "average per acre" figures for each of the site classes and the growth prediction technique, known as "Briegleb's Method", including the corrections for the various variables above enumerated, was then applied.

The results have already been reported on by the writer 7/. It is sufficient here to report merely that the reserve stand on the Kartar Unit will grow at the approximate rate of 90 board feet per acre per year during the next 40 year period. Since the Kartar Unit is somewhat poorer than the average on the Colville Reservation it seems reasonable to assume that the average growth rate of the reservation should be somewhat in excess of the above figure. The Kartar figures cannot be applied to other portions of the forest with accuracy, however, because of variations between different areas. To accurately determine potential growth on these areas the same detailed procedure herein described must be used.

## UNSOLVED PROBLEMS

As has been indicated the problem of predicting accurately the growth of the tree species associated with ponderosa pine has not been solved.

The younger age classes of the reserve stand, the seedlings, saplings and poles on which following generations must depend for the cut during the third and subsequent cycles, also constitute a serious unsolved problem, because the trees are so thick that growth stagnation now exists over extensive areas. Meyer, formerly one of the research men of the Pacific Northwest Forest Experiment, in his study of growth in selectively cut ponderosa pine forests 8/, concluded that the reproduction stands are growing at only 10

per cent of the normal rates that should be expected. He ended his report with the following statement, "This situation is deplorable. If stagnation is allowed to persist it will imperil the cuts at the end of the second and subsequent cutting cycles".

Obviously some feasible and economical method must be evolved for the thinning of the reproduction stand in such manner that maximum growth will result. Thinning by hand methods or by power saws would doubtless prove successful but the cost would be almost prohibitive. The writer believes that thinning by the use of controlled fire holds the most promise and on the Colville Reservation has supervised a number of controlled burning experiments to test such. Preliminary results appear very favorable 5/ 6/.

These are only two of the many unsolved problems having to do with the silviculture and protection of ponderosa pine forests.

## SUMMARY AND DISCUSSION

The best method by which actual and potential growth can be determined on ponderosa pine lands now being cut over for the first time is to establish representative permanent sample plots and to classify and measure each tree thereon at periodic intervals. Gradually, over the years, there will be accumulated accurate growth information and an intimate knowledge of the factors having a bearing on such. Permanent sample plots should certainly be established.

Lacking accurate permanent sample plot information the only alternative, in the meantime, is to conduct studies similar to the one herein briefly outlined. With several refinements the basic data collected will be of sufficient detail to provide for future changes in growth prediction techniques and for changes in utilization practice in the woods.

How the Indian Service can conduct such work with the present "corporal's guard" staff of foresters at each reservation is something that the writer is not prepared to recommend. It's certain that reasonably accurate growth data is essential for the formulation of management plans. It is also certain that intensive forestry will be practiced in the Pacific Northwest, with the depletion of the virgin timber stands. Perhaps someday, the Congressional committees can be persuaded to give us sufficient funds to do our job the way that it should be done.

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